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ings, addressed to observers on the immediate track, or more than ten miles from it; and, if carefully read, they will serve as good training for those who desire to take part in the investigation of these most disastrous upsets of the atmosphere. Circular 18 relates to observations to be made 'concerning the presence of electricity in tornadoes,' and asks thirty-two questions to this end. It is to be hoped that all persons living in the tornado districts of the country, and desiring to take part in the work as volunteer observers, will apply to the chief signal-officer for circulars of instructions.

It is worth mentioning, that the single waterspout recorded in the supplement to the pilot-chart of the North Atlantic for March occurred on Feb. 19, eighty miles east of Charleston, where it struck the schooner *Three sisters*, "carrying away main gaff, mainsail and foresail, and flattening in the after-hatches." This is evidently connected with the group of tornadoes above described.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible.*

Law connecting physical constants.

It may be of interest to some of your readers to know how the two formulæ published in the advertising columns of *Science*, No. 54, can be derived from the magnetic theory of molecular cohesion.

The work necessary to separate completely the particles of a body occupying the unit of volume can easily be calculated if we know the original attraction between every two particles, and its rate of change during expansion. For small magnetized spheres, this work is equal to the resultant attraction across the unit of surface. The latter, moreover, is necessarily equal to the pressure which the particles keep up by their incessant motion; which, again, is shown, by a well-known dynamical theorem, to be equal to the continued product of the coefficients of expansion and of resilience and the absolute temperature. This product is therefore finally the mechanical equivalent of the internal latent heat of the unit of volume of a liquid.

The theory does not apply to such liquids as water, in which, at low temperatures, a molecular re-arrangement is evidently going on; but in general, the higher the temperature, the more closely is the law fulfilled. The grouping of the atoms, and their vibration within the molecule, recently treated by Professor Eddy of Cincinnati, produce in the most unfavorable cases a variation of about thirty per cent from the theory: nevertheless, the general agreement is too great to attribute to chance, and becomes almost perfect when the causes alluded to are considered. The average value of the latent heat for ordinary liquids may be

shown to be about 1.2 times greater than for simple substances.

The molecules of all liquids appear to be very close together, notwithstanding the common prejudice that they are far apart; and, taking into account the comparative shortness of their free path, the coefficients alluded to may be obtained approximately by processes of ordinary differentiation, while their rate of change as the temperature increases can be determined as accurately as by actual observation.

The latent heat is found to vary inversely, the coefficient of expansion almost directly, as the free path of the molecule; and their continued product with the molecular weight is therefore nearly, but not quite, constant. The average value is about eight and a half; and any slight variations from this average are accounted for by the complete formula.

With these hints, and remembering that the inductive attraction between two small magnets varies as the seventh power of the distance inversely, while their normal attraction is inversely as the fourth, any mathematician familiar with the principles of physics may verify the laws already enunciated, and deduce others of equal importance in the same way.

The difference, for instance, between the specific heats in the state of liquid and vapor, is evidently the derivative of any true expression for the latent heat; and the critical temperature is found by supposing the latent heat equal to zero. The relations between all these quantities are represented with a remarkable degree of approximation.

The magnetic theory of cohesion promises to be, in molecular physics, what the law of universal gravitation has proved to be in astronomy. While carrying on the development as rapidly as possible myself, I would urge others, independently, to do the same, in the belief that this theory affords a most magnificent field, both for work and for discovery.

HAROLD WHITING.

Cambridge, March 17.

Relics in Ventura county, Cal.

Rincon Creek, fourteen miles west of San Buenaventura, is the dividing-line between Ventura and Santa Barbara counties. Where this creek flows into the ocean, at least a hundred acres are covered with shells, bones, fish-scales, and other kitchen debris of the Indians, who have lived here from time immemorial. The creek, which is fed by mountain springs, afforded good water; the ocean yielded fish and mollusks; while the foot-hills and mountains furnished wild game. A large variety of mollusks are still found at this point, and the shell-heaps indicate their great abundance in past time. Edible clams especially abounded; as *Pachydesma crassatelloides*, *Tapes staminea*, *T. diversa*, also *Mytilus californianus*.

Rincon Point was doubtless long a favorite resort for the early race that inhabited this coast. In one spot I found human bones, a few years since, which were in a semi-fossil state. They had been buried on the brow of a high bluff overlooking the sea, and were about four feet below the surface. One skull, that of an aged person, was perforated at the apex. The perforation seems to have been made by a sharp instrument, and some time before death, but for what purpose it is difficult to say. In another spot on the mesa, and three hundred yards from the ocean, occurred a burial-place in which the skeletons were reduced to an impalpable dust. In this dry soil and climate it must have required centuries for them to decay. In this place I found many 'sinkers' from three to twelve inches long, carved from sandstone, limestone, etc. They were from three-fourths of an

inch to an inch and a half in diameter in the middle, gradually sloping toward each end. There were also tubes of serpentine six or eight inches long, large chert knives, spear-points, and other things, all buried about four feet deep. Between this spot and the ocean was another burial-place, where, on the side of a declivity, many skeletons were found but eighteen inches to two feet below the surface, mingled with broken sandstone mortars and pestles, spear-points, arrow-heads, etc.

On the east side of the creek, between a high precipitous bluff and the ocean, is a three-cornered tract containing about ten acres, which is the site of an old rancheria or village. In the midst of this old town site I found a burial-place that indicated a somewhat more recent race than the first two mentioned. Here I exhumed a hundred or more skeletons, and at least a ton of relics: consisting of mortars and pestles of sandstone, ollas and tortilla stones of crystallized talc, pipes and bowls of serpentine, spear-points and arrow-heads of chert; also beads and 'charms,' and innumerable shell ornaments.

Last month I again visited this place, and exhumed a few more relics. In a spot about four by eight feet, and in the shape of a parallelogram, I found fifteen skeletons. With one of these were three tubes about three inches in length. In shape they were similar to the 'sinkers' already described, but with raised beads in the middle and at each end. These and some round beads were manufactured from serpentine. Beside the specimens mentioned, were many small shell disks made from *Olivella bicipitata*. An arrow-head was found with another skeleton. About three feet from the excavation described, I found three more skeletons, one of which was that of a child; and with it occurred two stone tubes similar to those above mentioned, also three round beads about one inch in diameter. The beads and tubes were of serpentine, containing seams of chrysolite, and were finely polished. With another skeleton, were five arrow-heads finely chipped from chert. One was a beautiful specimen with serrated edges, and a portion of the asphaltum with which it was fastened into the arrow still remained. With another, occurred several ornaments manufactured from *Lucapina crenulata*, and also an arrow-head. In a spot occupying less than fifteen feet in diameter I exhumed forty skeletons, piled one upon another. They were buried face downward, and could be counted only by the skulls.

STEPHEN BOWERS.

San Buenaventura, Cal.

The spirifers of the upper Devonian.

In the prefatory letter of the Report of progress, G. 7, of the Second geological survey of Pennsylvania, certain statements are made respecting the association and order of some of the fossil species of the Devonian rocks of New York, calling for comment.

It is stated on p. xx., in regard to *Spirifera disjuncta*, *S. mesocostalis*, and *S. mesostrialis*, that, "outside of Pennsylvania, these three species have been found, (1) never in any but Chemung rocks; (2) confined each to its own horizon; and (3) always in a fixed order from above downwards;" and, on p. xxi., that "Professor Hall has never seen any two of the three species co-existing in the same stratum; . . . that he cannot comprehend how *S. dj.* and *S. ms.* should be found together" (as they are reported to occur on p. 65 of the report).

Again (p. xxii.) it is stated that "*Orthis tulliensis*, in bed 41, § 13, p. 70, has certainly never before been seen in the Chemung 200' above the Genesee (i.e.,

300' above the Tully limestone), nor in company of *S. mesocostalis*."

The report of species in such 'uncanonical' positions in the strata is made a reason for concluding (p. xxvi.) that "the startling fossil species of this report will therefore be regarded by the palaeontological reader as only provisionally verified."

While the statements cited may express the general rule as to the occurrence of species in New-York state, there are specimens in Cornell university museum which do not bear out the statements.

In the first place, the two species *S. mesostrialis* and *S. mesocostalis* are found associated in the same stratum at Ithaca, N.Y., both in the mesostrialis zone and in the mesocostalis zone. Several instances can be shown where they occur on the same slab.

From a higher horizon in New-York state, and from several localities, either of these species may be found associated with *S. disjuncta*; and I have obtained each of the three species from the original Chemung locality at Chemung Narrows.

In the museum collection, is a small slab from that locality, containing beautiful representatives of *S. disjuncta* and *S. mesostrialis*; the latter preserving 'the fine radiate striae, with delicate concentric cross-lines' all over the surface of the shell, and with 'the broad median fold without a depression,' which are described as distinctive characters of the species (Pal. N.Y., vol. 4, p. 243).

The other specimen, only a couple of inches distant, has the characteristic plications on the median fold, and, with a surface equally well preserved, shows not the least trace of radiate or concentric striae, unmistakably indicating *S. disjuncta*.

From the same locality, though not on this individual slab, are specimens of both varieties of the so-called *S. mesocostalis*, — the large, coarse form with angular plications and reduplicated fold, and the more finely plicated form with prolonged lingeline, which is more characteristic of a lower horizon.

These higher representatives of *S. mesocostalis* are, however, generally distinguished from the earlier representatives by a well-developed median septum in the ventral valve, — a character of which only a trace is seen in specimens from the Ithaca beds, reminding us of the genus *Spiriferina*. The punctate shell-structure of that genus has not, however, been detected in any specimens thus far examined.

In regard to *Orthis tulliensis*, it may be said that the common *Orthis*, occurring at the base of the Ithaca fauna, within a few hundred feet of the Genesee shale (less than 500), at its first appearance resembles *O. tulliensis* in form and general characters; though for distinction it may be appropriate to call it a variety of *O. impressa*, since a little higher, and in the same fauna, the typical *O. impressa* appears in abundance.

Still, there are specimens in the collection from the lowest zone which it would be difficult for any one to distinguish, by macroscopic or microscopic characters, from *O. tulliensis*, occurring, as they do, in a calcareous stratum.

I have no single slab containing this form with *S. mesocostalis*, but the latter is found both above and below the stratum containing the *Orthis*.

The record of an *O. tulliensis* at 200 feet above the Genesee shale in Pennsylvania seems, therefore, indicative of a careful identification of the species upon morphologic characters alone, without prejudice as to its supposed horizon or range.

In regard to the identification of these upper Devonian faunas of Columbia county, Penn., it may be said, that in the association of species, and the